



In paragraph 1 of the Specification section, the Examiner has objected to the Specification based on formalities wherein figures were referenced using lower case letters. In response, the Applicant has replaced all lower case figure references in the specification with upper case figure references to match the drawings submitted with the application.

In paragraph 3, under Claim Rejections, the Examiner has objected to claim 13. Original claim 13 has herein been deleted.

In paragraph 4, under Claim Rejections, the Examiner has rejected claims 17-20 under 35 U.S.C. § 112, first paragraph. Original claims 17-20 have been deleted.

In paragraph 7, under Claim Rejections, the Examiner has rejected claims 1-20 under 35 U.S.C. § 112, second paragraph, as being indefinite. The specific rejections are outlined in paragraph 8. The Applicant has modified claim 1 to remove the offending language and respectfully submits that the rejection based on these grounds has been traversed.

In paragraph 10, under Claim Rejections, the Examiner has rejected claims 1-2, 5-14 and 17-20 under 35 U.S.C. § 103(a) as being unpatentable over Applicant's admitted prior art (APA) in view of U.S. Patent 5,314,572 (Core, et al.). The Examiner has also rejected, in paragraph 11, claims 1-2, 4-12 and 5-16 under 35 U.S.C. § 103(a) as being unpatentable over the APA in view of U.S. Patent 5,083,857 (Hornbeck). Further, the Examiner rejected claim 3 under 35 U.S.C. § 103(a) as being unpatentable over the APA in view of Core, the APA in view of Hornbeck, or either in further view of U.S. Patent 5,493,177 (Muller, et al.).

In response to all three rejections under § 103(a), the Applicant has modified Claim 1 to add two limitations. The first limitation is that the etching rate differential between the structural material and the sacrificial material with respect to the non-liquid etchant used be high and, second, that a barrel etcher be used to apply the non-liquid etchant to the device.

The use of a barrel etcher is not known in the art for the purpose outlined in the Applicant's disclosure. In the device described in the disclosure, and with any device which is constructed in accordance with the Applicant's invention, a captured microstructure is constructed in the sealed cavity. Thereafter, holes are etched in the walls of the sealed cavity for purposes of introducing an etching agent to remove the sacrificial material which binds the microstructure to the substrate. A non-liquid etchant is utilized to eliminate the acknowledged problem of surface tension.

It is typical for the microstructures which would be built in accordance with this invention to be on the order of hundreds of microns in width. It is also undesirable to make multiple holes in the sealed cavity because, when such holes are sealed over, the material used as a sealant constructs posts within the sealed cavity that could limit the size and mobility of the microstructure. Therefore, it is desirable to minimize the number of holes in

the sealed cavity and to place the holes at or near the edges of the sealed cavity, as opposed to in the center.

Due to the nature of the charged plasma used as the etching agent, when introduced into the sealed cavity, it has a tendency to become electrostatically attracted to the surfaces of the microstructure and the substrate. Therefore, the areas containing sacrificial materials near the holes may be etched away rather quickly while areas inside of the cavity that are far from the etch holes, are etched extremely slowly if at all. Parts of the microstructure may be a distance of hundreds of microns away from the etch holes. Because of the tendency of the etchant to adhere to the walls of the microstructure, very little of the etchant may find its way to the center of the sealed cavity.

For this reason alone, it is not obvious to use a non-liquid etchant within a sealed cavity. Further, to use a precision etching apparatus to perform this task makes the manufacture of devices non-economical because of the cost of the apparatus and the possible number of units that could be produced in a given time, due to the extremely long etching period required. None of the references cited by the Examiner solve this problem. Therefore, the Applicant has added the limitation of using a barrel etcher, which is typically not used for precision etching, to deliver the non-liquid etchant. The barrel etcher is considered a non-precision etching device and is often used for "clean-up" at the conclusion of an etching process. Further, the barrel etcher is capable of etching dozens of wafers, each of which may contain thousands of devices, at the same time. This requirement makes the process economical, even with the extended etching times required to release the microstructure, which can be on the order of hours or even tens of hours.

None of the references cited by the Examiner, either in combination with the ATA or with each other, teach the use of a barrel etcher to introduce a non-liquid plasma into a sealed cavity for purposes of releasing a MEMS microstructure from a substrate. As a result, the Applicant's submit that the Claims 1-5 and 21-23, as amended, are not obvious in view of the APA taken in combination with Core, Hornbeck, Mueller, et al. or any combination thereof.

Further, the Applicant's have added the limitation that the etch rate differential with respect to the non-liquid etchant of the structural material and the sacrificial material must be high. This is a result of the extremely long etch times in the barrel etcher when the sealed cavities are exposed to the non-liquid etch agent. If the etch rate differential is not high enough, the non-liquid etch agent will attack the microstructure and the cavity walls as well as the sacrificial material during the extended time when the microstructure is exposed to the non-liquid etch agent. Therefore, only certain combinations of materials can be used as a sacrificial material in combination with a particular structural material. Aluminum and



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photoresist with an oxygen plasma etch agent is the preferred choice when practicing this invention, as the etch rate differential for these two materials are high with respect to an oxygen plasma etchant, however, other combinations may be acceptable.



CONCLUSION

The Applicant has addressed all of the informalities pointed out by the Examiner in the Office Action and further, has amended the claims and given reasons why the claims, as amended, are not obvious in view of the APA in combination with Core, Hornbeck or Mueller, et al. or any combination thereof. The Applicant therefore respectfully requests that the claim rejections under 35 U.S.C. § 103(a) be withdrawn and the pending claims, as amended, be allowed at the earliest possible time.

Respectfully submitted,

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ADDENDUM
(Marked Up Claims)

1. (Amended) A method of fabricating a microstructure in a sealed cavity [for containing a microstructure] comprising the steps of :

providing a substrate;

forming a microstructure composed of a structural material on said substrate in a sealed cavity, said microstructure being secured to said substrate at one or more points by a sacrificial material;

[depositing one or more sacrificial layers on said substrate;

depositing a first seal layer on top of said one or more sacrificial layers;]

forming one or more holes in said sealed cavity; [first seal layer, said holes communicating with said one or more sacrificial layers;]

introducing [an] a non-liquid etchant into said sealed cavity through said one or more holes using a barrel etcher, said etchant having a high etch rate with respect to said sacrificial material and a low etch rate with respect to said structural material, such that said sacrificial material is removed; and [such that said one or more sacrificial layers are etched away by said etchant;

depositing a second seal layer on top of said first seal layer, said second seal layer] sealing said one or more holes in said sealed cavity. [in said first seal layer;]

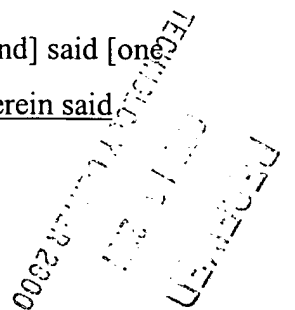
[wherein said etchant used to remove the last of said sacrificial layers is a non-liquid material.]

2. (Amended) The method of claim 1 further comprising the step of choosing said etchant to etch said sacrificial [layers] material without substantially etching said substrate or said [first seal layer.] microstructure.

3. (Unchanged)

4. (Amended) The method of claim 2 wherein said etchant is oxygen plasma, [and] said [one or more] sacrificial material [layers are] is [composed of] photoresist[.] and wherein said structural material is aluminum.

5-20. (Deleted)



Also enclosed is a return postcard. Please date stamp the postcard and return it to the address thereon in order to acknowledge receipt of the above-mentioned correspondence.



Respectfully submitted,

A handwritten signature in black ink, appearing to read "Dennis M. Carleton".

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